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(54) Dual band radio apparatus

(57) The invention relates to a radio apparatus (1), particularly for mobile use, comprising an antenna arrangement (5) with at least the first antenna element (20) and a second antenna element, wherein said first antenna element (20) and said second antenna element are coupled so that said antenna arrangement (5) is operational in at least to difference frequency bands and wherein the two antenna elements are connected to a ground plate (10) by first and second connecting means (50 and 60).

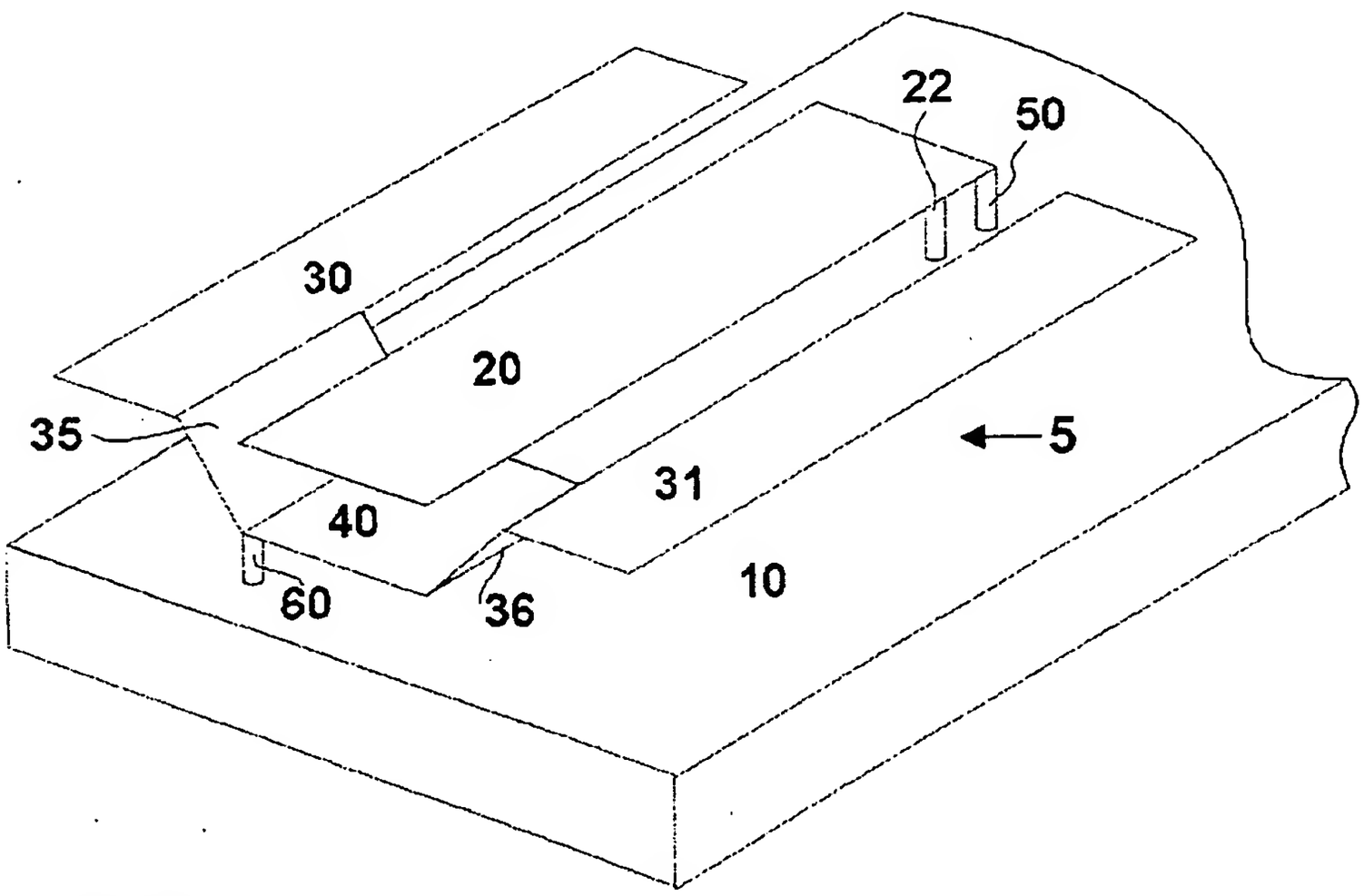

Fig 2

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Description

Prior art

[0001] The invention relates to a radio apparatus, particularly for mobile use, comprising an antenna arrangement with at least a first antenna element and a second antenna element. From the international application WO 97/18601, a radio device is already known with a first antenna element and a second antenna element, this radio device being operational in at least two different frequency bands.

Advantages of the invention

[0002] The invention according to the features of the independent patent claim has the advantage that the volume of the antenna element is well used at all frequency bands of operation. Therefore, the radiation which is incident on the antenna arrangement or which is emitted from the antenna arrangement do not only originate from one point or a single part of the antenna arrangement but from several parts of the antenna arrangement. Therefore, it is possible to combine high efficiency of the antenna arrangement with a small size of the antenna arrangement. Furthermore, it is possible to build the antenna arrangement in a very compact way, as the maximum dimension required is only one eighth of the wavelength at the lowest frequency of operation.

[0003] The dependent patent claims comprise features that allow further useful improvements of the radio apparatus of the independent patent claim.

[0004] It is particularly advantageous that said first connecting means are provided substantially at a first end of the first antenna element. Thus, the first antenna element can be used together with the connecting ground plate substantially as a folded monopole antenna for emitting and/or receiving radio frequency radiation.

[0005] Furthermore, it is advantageous that the second antenna element includes a coupling element providing said capacitive coupling between said first antenna element and said second antenna element, said coupling element being provided close to a second end of said first antenna element so as to provide said electromagnetic interaction. Thus, the coupling between the first antenna element and the second antenna element can be implemented in a very simple manner. Especially, it is possible to conceive the antenna arrangement with a simple mechanical structure.

[0006] Furthermore, it is advantageous that said capacitive coupling between said first antenna element and said second antenna element is provided by interacting metallic surfaces, by a metallic surface interacting with a metallic wire and/or by interacting edges of metallic surfaces. This allows a variety of different possible designs of the antenna arrangement.

[0007] Furthermore, it is advantageous that said second antenna element includes two subelements and that said second connecting means are provided as a second shorting pin common to said two subelements. Thus, it is possible to combine high efficiency of the second antenna element and a small size of the two subelements.

[0008] Furthermore, it is advantageous that the two subelements are provided substantially symmetrically in respect of the centerline of that first antenna element and that said common second shorting pin is provided asymmetrically in respect of said centerline. Thus it is possible to place the resonances of the subelements slightly apart in order to obtain a greater band width of the resonance bands where the antenna arrangement is operational.

[0009] Furthermore, it is advantageous that said ground plate substantially defines a first plane, that said first antenna element and said second antenna element are provided substantially in a second plane and that the second plane is substantially parallel to the first plane. Thus, a better directionality of the antenna arrangement is possible. Furthermore, a good SAR-performance (specific absorption rate) is possible.

[0010] Furthermore, it is advantageous that said second plane and said third plane are substantially identical. Thus, the two antenna elements have almost the same characteristic in respect to space directionality.

[0011] Furthermore, it is advantageous that the first antenna element is provided as a capacitively coupled planar inverted F-antenna, a capacitively coupled patch antenna, an capacitively coupled inverted F-antenna or a capacitively coupled curled up inverted F-antenna. Thus, it is possible, to shape the first antenna element mechanically so that it fits into the form of a given design.

[0012] Furthermore, it is advantageous that the subelements are short circuit patch antennas. Thus, the second antenna element is easy to shape and to be adapted to a given design of the radio apparatus.

[0013] Furthermore, it is advantageous that the antenna arrangement operates at a first frequency band at a center frequency of about 900 MHz and that the antenna arrangement operates as well at a second frequency band, either at a center frequency of alternatively about 1800 MHz or 1900 MHz or at a center frequency comprised inbetween 1800 MHz and 1900 MHz. Thus, it is possible to use the radio apparatus in cellular radio telecommunication networks, as, for example, GSM-Networks, UMTS-Networks, GPRS-Networks and/or DECT-Networks.

Drawings

[0014] The invention is shown in the drawings and described in detail in the following description.

[0015] Figure 1 shows an antenna arrangement together with a ground plate of a radio apparatus in top view.

[0016] Figure 2 shows the antenna arrangement in perspective view together with a cutout of the ground plate.

[0017] Figure 3 shows a second embodiment of the antenna arrangement together with a cutout of the ground plate.

[0018] Figure 4 shows the second embodiment of the antenna arrangement together with the ground plate of the radio apparatus in top view

[0019] Figure 5 shows a third embodiment of the antenna arrangement together with a cutout of the ground plate.

[0020] Figure 6 shows a fourth embodiment of the antenna arrangement together with a cutout of the ground plate.

[0021] Figure 7 shows a fifth embodiment of the antenna arrangement together with a cutout of the ground plate.

[0022] Figure 8 shows a radio apparatus in front view.

[0023] Figure 9 shows the radio apparatus in side view including the ground plate and the antenna arrangement.

Description

[0024] For better understanding, the figures 8 and 9 are described first.

In figure 8, a radio apparatus 1 with a housing 2, input means 4 and output means 3 is depicted. The input means 4 are provided, for example, as keys, keyboards, microphones, touch screens and the like. The output means are provided, for example, as display means, loudspeakers and the like. The housing 2 has substantially a cuboidic form with a front side and with a back side, both shaped substantially as rectangles and with two lateral sides having a smaller surface than the front side. Figure 8 depicts the front side of the housing with the output means 3 in the upper portion of the front side and with the input means 4 in the lower portion of the front side.

[0025] Figure 9 depicts a side view of the radio apparatus 1 by showing a lateral side of the housing 2 with the output means 3 and the input means 4. In the interior of the housing 2 is provided a ground plate 10 and an antenna arrangement 5. The antenna arrangement 5 is connected to the ground plate by means of first and second connecting means 50, 60. The ground plate 10 is provided substantially elongated in two dimensions and therefore defines a first plane 11. The antenna arrangement 5 is also elongated in two dimensions and defines a second plane 21.

[0026] Figure 1 is a representation in top view of the ground plate 10 and of the antenna arrangement 5, the antenna arrangement 5 being connected to the ground plate 10. Figure 2 shows in perspective view said antenna arrangement 5 and a cut out of said ground plate 10. In the following, figure 1 and figure 2 are described together. The ground plate 10 has the form of a rectangle of conducting material and defines therefore the first plane 11. The antenna arrangement 5 comprises a first antenna element 20 and a second antenna element.

[0027] The first antenna element 20 is rectangularly shaped in an oblong manner and it is made of a conducting material, for example a metal. Furthermore the first antenna element 20 defines the second plane 21 which is parallel to the first plane 11. Therefore, the first antenna element 20 is provided at a certain distance of the ground plate 10. The second antenna element comprises a first subelement 30, a second subelement 31, a first bonding element 35, a second bonding element 36 and a coupling element 40, all these parts of the second antenna element being made of rectangular conducting plates of different size. The first and the second subelement 30, 31 have the same size and are shaped in an oblong manner. The coupling element 40 has substantially a quadratic form and the length of one of its sides is essentially the same as the width of the first antenna element 20. The first and second bonding elements 35, 36 have the same size; their length is essentially the same as the length of one side of the coupling element 40. The first bounding element 35 connects the first subelement 30 with the coupling element 40 and the second bounding element 36 connects the second subelement 31 with the coupling element 40, so that the second antenna element forms one piece. Particularly, the bonding elements 35, 36 provide an electrically conducting connection between the coupling element 40 and, respectively, the subelements 30, 31 of the second antenna element.

[0028] The first antenna element 20 is electrically connected to the ground plate 10 by first connecting means 50, provided near one of the corners of the rectangularly shaped first antenna element 20 or at a first of the small sides, i.e. at one end, of the first antenna element 20. As the first antenna element 20 has an oblong form, the location of the first connecting means 50 defines a first end of the first antenna element 20. The first connecting means 50 are provided in the form of a shorting pin and are therefore also referred to as the first shorting pin 50.

[0029] The subelements 30, 31 of the second antenna element are provided symmetrically relative to the first antenna element 20 and parallel to the first antenna element 20. Therefore, the subelements 30, 31 are provided in the same second plane 21 as the first antenna element 20. The symmetry of the location of the subelements 30, 31 is defined by the center line of the first antenna element 20 which is a symmetry axe parallel to the long side of the first antenna element 20. The width of the subelements 30, 31 is provided smaller than that of the first antenna element 20. The first subelement 30 is oriented parallel to the first antenna element 20. Furthermore, the subelements 30, 31 and the first antenna element 20 have substantially the same length and are provided side by side. The second subelement 31 is located identically relative to the first subelement 30 but symmetrically on the other side of the first antenna ele-

ment 20.

[0030] At one end of the first and the second subelement 30, 31 the two subelements 30, 31 are connected by means of the first and second bonding element 35, 36 to the coupling element 40, in order to form a single piece. The coupling element 40 has also rectangular form and is located parallel to the first and the second plane 11, 21 in a plane inbetween the first and the second plane 11, 21. To connect the coupling element 40 with the first subelement 30, the first bonding element 35 is located in a plane inclined relative to the first and the second plane 11, 21. Analogously, the second bonding element 36 is inclined relative to the first and the second plane 11, 21, as it connects the coupling element 40 with the second subelement 31. The coupling element 40 is provided so that an important portion of the coupling element 40 is situated near to a second end of the first antenna element 20 which is opposite to the first end where the first connecting means 50 are situated.

[0031] The antenna arrangement 5 is provided so that there is a relatively large coupling area where the coupling element 40 and the second end of the first antenna element 20 are fairly close to each other. The interaction of the antenna arrangement 5 with radio frequency radiation implies that the very narrowly spaced surfaces of the coupling element 40 and of the second end of the first antenna element 20 have the effect of a capacitive coupling between the first antenna element 20 and the second antenna element. The capacitive coupling between the two antenna elements is therefore provided like the coupling between the two plates of a condensator.

[0032] At the most distant corner of the coupling element 40 relative to the first connecting means 50 are provided second connecting means 60 which connect the coupling element 40 electrically to the ground plate 10. The second connecting means 60 are provided in the form of a shorting pin and are therefore also referred to as the second shorting pin 60. The second shorting pin 60 can be provided in the same manner as or differently to the first shorting pin 50, e.g. by means of a piece of wire or other connecting means.

[0033] Differently to the shape of the second antenna element, the second connecting means 60 are not provided symmetrically to the two subelements 30, 31 of the second antenna element. By providing this asymmetry in the location of the second connecting means 60, it is possible to provide an enlargement of the frequency band of operation of the antenna arrangement 5, especially in respect of the frequency band, the second antenna element is tuned to

[0034] A feeding element 22 is provided with the antenna arrangement 5 in order to connect the antenna arrangement 5 to reception and transmission circuitry provided with the radio apparatus 1. For these purposes, the feeding element 22 is connected, in an advantageous embodiment of the invention, to the first antenna element 20. In other embodiments of the invention the feeding element 22 may also be connected to the second antenna element. In figure 1 and 2 the feeding element 22 is provided relatively close to the first connecting means 50 in order to form a planar inverted F-antenna. Other locations of the feeding element 22 relative to the first antenna element 20 and relative to the second antenna element are possible according to the invention and are mainly dependent on the impedance required by a feeding circuit that is not shown. The feeding element 22 connects the feeding circuit and the antenna arrangement 5. The feeding circuit can also be replaced by a receiving circuit or by a combined feeding and receiving circuit.

[0035] Alternative embodiments of the described parts of the radio apparatus 1 or of the antenna arrangement 5 are mentioned in the following.

[0036] The feeding can be provided in different ways, for example by a slot feeding with a slot in the ground plate providing an electromagnetic coupling between the feeding element 22 and one of the antenna elements.

In other embodiments of the invention, a stub is provided to couple electromagnetically the feeding circuit to one of the antenna elements and to provide the feeding in this manner.

[0037] The first shorting pin 50 is a piece of wire connecting the first antenna element 20 with the ground plate 10. In an advantageous embodiment of the invention, these first connecting means 50 are provided as a shorting pin or as a shorting bridge made of conducting material which electrically connect the ground plate 10 with different parts of the antenna arrangement 5.

[0038] The ground plate 10 is a conducting ground plate, for example made of a metallic material. The ground plate 10 is, in a particular advantageous embodiment of the invention, fixed to a substrate which gives a mechanical stability to the conducting ground plate 10. The ground plate 10 can be provided as the circuit board of a radio apparatus 1 to be described together with figure 7. Naturally, it is possible to provide the ground plate 10 in such a manner that the mechanical stability is given by its own, for example by using as a conducting ground plate 10 a metallic panel of sufficient thickness. The conducting ground plate 10 is provided substantially in a first plane 11 which will be described together with figure 8. This means that the ground plate 10 is substantially flat. This does not exclude that some parts of the ground plate 10 are provided outside of the first plane 11.

[0039] The second antenna element is in an advantageous embodiment of the invention provided as a flat conductor, for example a metallic plate or a metallic layer on a mechanically fixing substrate. However, other embodiments, for example conductors in the form of a wire or layers in the form of a wire and being shaped, for example, in a helical way, are possible embodiments of the second antenna element.

[0040] Likewise, the first antenna element is, in the

embodiment of figure 1 and 2, a conducting plate but can be shaped in other ways, several of which are described in the following figures.

[0041] Furthermore, it is possible that the subelements 30,31 of the second antenna element are not in the same plane as the first antenna element 20. Thus the subelements can be located in a plane substantially parallel to the ground plate 10 but closer to or further from the ground plate 10 that the first antenna element 20.

[0042] Figure 3 depicts the antenna arrangement 5 together with a part of the ground plate 10 in a second embodiment. Likewise, figur 4 is a representation in topview of the ground plate 10 and of the second embodiment of the antenna arrangement 5. Therefore, figure 3 and 4 are described together. Identical reference numerals as in the preceding figures refer in figure 3 and 4 to the same parts or elements of the radio apparatus 1 or of the antenna arrangement 5. In the second embodiment, the first antenna element 20 is provided as a capacitively coupled patch antenna. The main portion of the first antenna element 20 is a metallic rectangle formed in an oblong manner, as described in connection with figures 1 and 2. At the first end of the first antenna element 20, there is an electrically conducting connection between the first antenna element 20 and the ground plate 10 along the entire small side of the first antenna element 20. This conducting connection can be called a connecting bridge and is another embodiment of the first connecting means 50. Another way to describe the second embodiment of the first connecting means 50 is that the small side of the metallic plate of which is formed the first antenna element 20 is bent by 90 degrees at a certain distance from one of its ends. This distance is equal to the distance of the first antenna element 20 and the ground plate 10. Thus, the bent end of the first antenna element 20 connects the first antenna element 20 to the ground plate 10 and forms the first connecting means 50 in a bridge-like manner. So, the first connecting means 50 are provided as a connecting bridge. In the embodiment of figure 3 and 4, the feeding element 22 is provided in a similar manner. The feeding element is realized as an electrically conductive connection between the first antenna element 20 and the feeding circuit. The feeding element 22 is provided near the first end of the first antenna element 20, i.e. near the first connecting means 50, and it is formed as a metallic plate, parallel to the small side of the first antenna element 20, that connects the first antenna element 20 with the feeding circuit. Thus, in the second embodiment, the feeding element 22 is provided as a connecting bridge between the first antenna element 20 and the feeding circuit.

[0043] Figure 5 depicts the antenna arrangement 5 in a third embodiment of the invention and furthermore, figure 5 shows a part of the ground plate 10. Identical reference numerals as in the preceding figures refer in figure 5 to the same parts or elements of the radio apparatus 1 or of the antenna arrangement 5. The first antenna element 20 is provided as a inverted F-antenna. The main portion of the first antenna element 20 has the form of an elongated wire, parallel to the first plane 11. At the first end of the first antenna element 20 the first shorting pin 50 connects the first antenna element 20 to the ground plate 10. Near the first shorting pin 50 the feeding element 22 is provided to connect the first antenna element 20 to the feeding circuitry of the radio apparatus 1. The first antenna element 20 is provided parallel to the first plane 11 at a certain distance to the ground plate 10. The second antenna element is provided in the same manner as described in figures 1 to 4. Therefore the coupling between the first antenna element 20 and the second antenna element is obtained by means of the interaction of the second or free end of the first antenna element 20, shaped as a wire, with the coupling element 40 of the second antenna element. The symmetry of the location of the subelements 30, 31 is defined by the center line of the first antenna element 20, which is, in the case of the third embodiment, parallel to the longest extension of the first antenna element 20.

[0044] Figure 6 depicts the antenna arrangement 5 together with a part of the ground plate 10 in a fourth embodiment of the invention. The first antenna element 20 is provided as a curled up inverted F-antenna. The first antenna element 20 is therefore shaped like a wire and the curled form of the first antenna element 20 is in the form of a meander. This allows a very small size of the antenna element for a given minimal frequency of operation of the first antenna element 20. The meander-shaped first antenna element 20 is again connected at its first end to the ground plate 10 by means of the shorting pin 50 and the second or free end of the first antenna element 20 interacts with the coupling element 40 of the second antenna element if radio frequency radiation is incident on or emitted from the antenna arrangement 5. The meander-shaped or curl-shaped first antenna element 20 defines the second plane 21. The feeding element 22 is again provided near the first connecting means 50 at the first end of the first antenna element 20, which is opposite of the second or free end, the second or free end being coupled to the coupling element 40 of the second antenna element. In case of an interaction of the antenna arrangement 5 with a radiofrequency radiation field, the coupling between the first and the second antenna element is realized by means of the interaction of the coupling element 40 and the wire-shaped second end of the first antenna element 20.

[0045] Figure 7 depicts a fifth embodiment of the antenna arrangement 5 and a part of the ground plate 10. In the embodiment of figure 7 the first antenna element 20 is again shaped as a planar inverted F-antenna, like it was described in figure 1 and 2. In figure 7, the second antenna element is shaped differently from the embodiments described with the above mentioned figures. In figure 7 the second antenna element comprises again the first subelement 30, the second subelement 31 and

the coupling element 40. These three parts of the second antenna element are again rectangularly shaped. At the difference of the above mentioned figures, however, the coupling element 40 is provided in the plane defined by the two subelements 30, 31. The coupling element therefore is parallel to the ground plate 10 at the same distance as the elements 30, 31. Since they are in the same plane, no bonding elements 35, 36 as in figures 1 to 6 are needed. Therefore, the first subelement 30 is directly connected to the coupling element 40 and the second subelement 31 is also directly connected to the coupling element 40. The coupling between the first antenna element 20 and the coupling element 40 is provided by a narrow distance between the second end of the first antenna element 20 and the coupling element 40. This distance is less than the distance between the first antenna element 20 and the subelements 30, 31.

[0046] The antenna arrangement 5 as it is described is operational with at least two different frequency bands. The exact value of the center frequency and the band width of the frequency bands is dependent on the dimensions and the shapes of the first antenna element 20, the second antenna element and the kind of coupling between these two antenna elements. The antenna arrangement 5 can be used to emit radio frequency radiation which means that the radio apparatus 1 is used as a transmitter. Furthermore, the antenna arrangement 5 can be used as a reception antenna which means that the radio apparatus 1 can be used as a receiver. It is also possible to use the antenna arrangement 5 both, as an emitting antenna, and as a receiving antenna, and likewise the radio apparatus 1 as a transceiver.

[0047] The antenna arrangement 5 according to the invention is very flexible concerning the tuning to particular frequency bands of operation. This feature is combined with the fact that the radiation not only originate from one point or a single part of the antenna arrangement but from several parts of the antenna arrangement 5. Analogously, for the receiving mode of the antenna arrangement 5, radiation is not only incident to one point or to a single part of the antenna arrangement 5 but to several parts of the antenna arrangement 5. The choice of dimensions on the first antenna element 20 will mainly affect the lower frequency band of operation of the antenna arrangement 5. The choice of dimensions on the second antenna element and especially on the first and second subelements 30, 31 will mainly effect the resonance in the higher frequency band. The minimum required length of the first antenna element 20 can be as low as substantially one eighth of the wavelength at the lowest frequency of operation.

[0048] The provided frequency bands of operation are especially: for the first frequency band, the 900 MHz band used in cellular radio networks, e.g. GSM-networks, and for the second frequency band the 1800 MHz and/or 1900 MHz band used in cellular and other radio networks, e.g. GSM-networks, UMTS-networks, GPRS-networks and DECT-networks.

[0049] The antenna arrangement 5 can be placed and shaped mechanically in order to obtain a large tolerance to, for example, the finger of an operator held very close to the antenna element 5. The center frequencies and the band widths of the frequency bands of operation of the antenna arrangement 5 are also dependent on the coupling scheme provided by the second end of the first antenna element 20 and by the coupling element 40 of the second antenna element. The embodiments of the invention described are only meant as examples for possible embodiments of the invention. For example, there can be corners cut out of elements or corners can be provided round, rectangular parts can be shaped differently and do not to be flat, and especially different coupling scenarios can be applied, which can be described as coupling schemes between the free end of the first antenna element 20 and the coupling element 40 mixing the coupling schemes described in the figures. For example a mixing of the coupling scheme in figure 2 and 7 is possible. In this way the antenna arrangement 5 as a whole can easily be fitted into a range of different designs. Nevertheless, other embodiments of a capacitive coupling are possible, for example, by means of a discrete capacitor between the first antenna element 20 and the second antenna element.

[0050] Furthermore the subelements 30, 31 of the second antenna element can be provided in another plane than the second plane. This other plane can be parallel to the ground plate 10 or it can be inclined. This means that it is possible to provide these subelements 30, 31 at a different distance from the ground plate 10 than the first antenna element 20. It is possible to provide one of the subelements 30, 31 in another plane, i. e. at another distance of the ground plate 10 than the other of the subelements 30, 31. Furthermore, it is also possible to provide a capacitive coupling between the ground plate 10 and one of the subelements 30, 31 or all of the subelements 30, 31 in order to lower the dimensions of the subelements 30, 31 needed for a given frequency of operation. This capacitive coupling can be provided, for example by lowering the distance between the ground plate 10 and the subelements 30, 31 or by providing a discrete capacitor between the ground plate 10 and the subelements 30, 31. Furthermore, it is possible that the subelements 30, 31 are provided with different length so that one of the subelements 30, 31 is operational at a different frequency of operation than the other subelement 30, 31. These different frequencies can be provided in different frequency bands in order to operate the antenna arrangement 5 in three or more frequency bands.

Claims

1. Radio apparatus (1), particularly for mobile use, comprising an antenna arrangement (5) with at

least a first antenna element (20) and a second antenna element, wherein a capacitive coupling provides an electromagnetic interaction between the first and the second antenna element when radio frequency radiation is incident on or emitted from said antenna arrangement (5), said interaction providing that the antenna arrangement (5) is operational in at least two frequency bands, characterized in that said radio apparatus (1) comprises a conducting ground plate (10), that said first antenna element (20) is electrically connected to said ground plate (10) by first connecting means (50) and that said second antenna element is electrically connected to said ground plate (10) by second connecting means (60).

2. Radio apparatus (1) according to claim 1, characterized in that said first connecting means (50) are provided substantially at a first end of said first antenna element (20).

3. Radio apparatus (1) according to claim 1 or 2, characterized in that the second antenna element includes a coupling element (40) providing said capacitive coupling between said first antenna element (20) and said second antenna element, said coupling element (40) being provided close to a second end of said first antenna element (20) so as to provide said electromagnetic interaction.

4. Radio apparatus (1) according to any of the preceding claims, characterized in that said capacitive coupling between said first antenna element (20) and said second antenna element is provided by interacting metallic surfaces, by a metallic surface interacting with a metallic wire and/or by interacting edges of metallic surfaces.

5. Radio apparatus according to any of the preceding claims, characterized in that said second antenna element includes two subelements (30, 31) and that said second connecting means (60) are provided as a second shorting pin common to said two subelements (30, 31).

6. Radio apparatus (1) according to claim 5, characterized in that the two subelements (30, 31) are provided substantially symmetrically in respect of the centerline of said first antenna element (20) and that said common second shorting pin (60) is provided asymmetrically in respect of said centerline.

7. Radio apparatus (1) according to any of the preceding claims, characterized in that said ground plate (10) substantially defines a first plane (11), that said first antenna element (20) and said second antenna element are provided substantially in a second plane (21) and that the second plane (21) is substantially parallel to the first plane (11).

8. Radio apparatus (1) according to any of the preceding claims, characterized in that the first antenna element (20) is provided as a capacitively coupled planar inverted F-antenna, a capacitively coupled patch antenna, an capacitively coupled inverted F-antenna or a capacitively coupled curled up inverted F-antenna.

9. Radio apparatus (1) according to any of the claims 5-8, characterized in that the subelements (30, 31) are short circuit patch antennas.

10. Radio apparatus (1) according to any of the preceding claims, characterized in that the antenna arrangement (5) operates at a first frequency band at a center frequency of about 900 MHz and that the antenna arrangement (5) operates as well at a second frequency band, either at a center frequency of alternatively about 1800 MHz or 1900 MHz or at a center frequency comprised inbetween 1800 MHz and 1900 MHz.

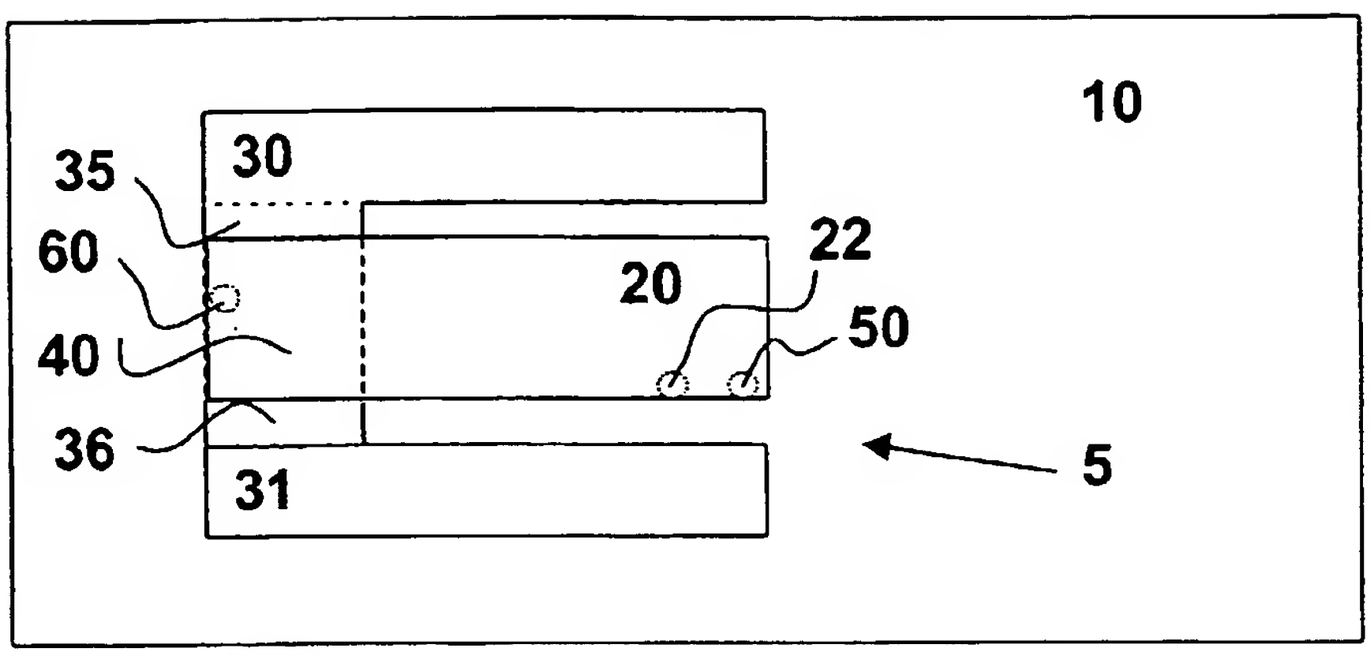

Fig 1

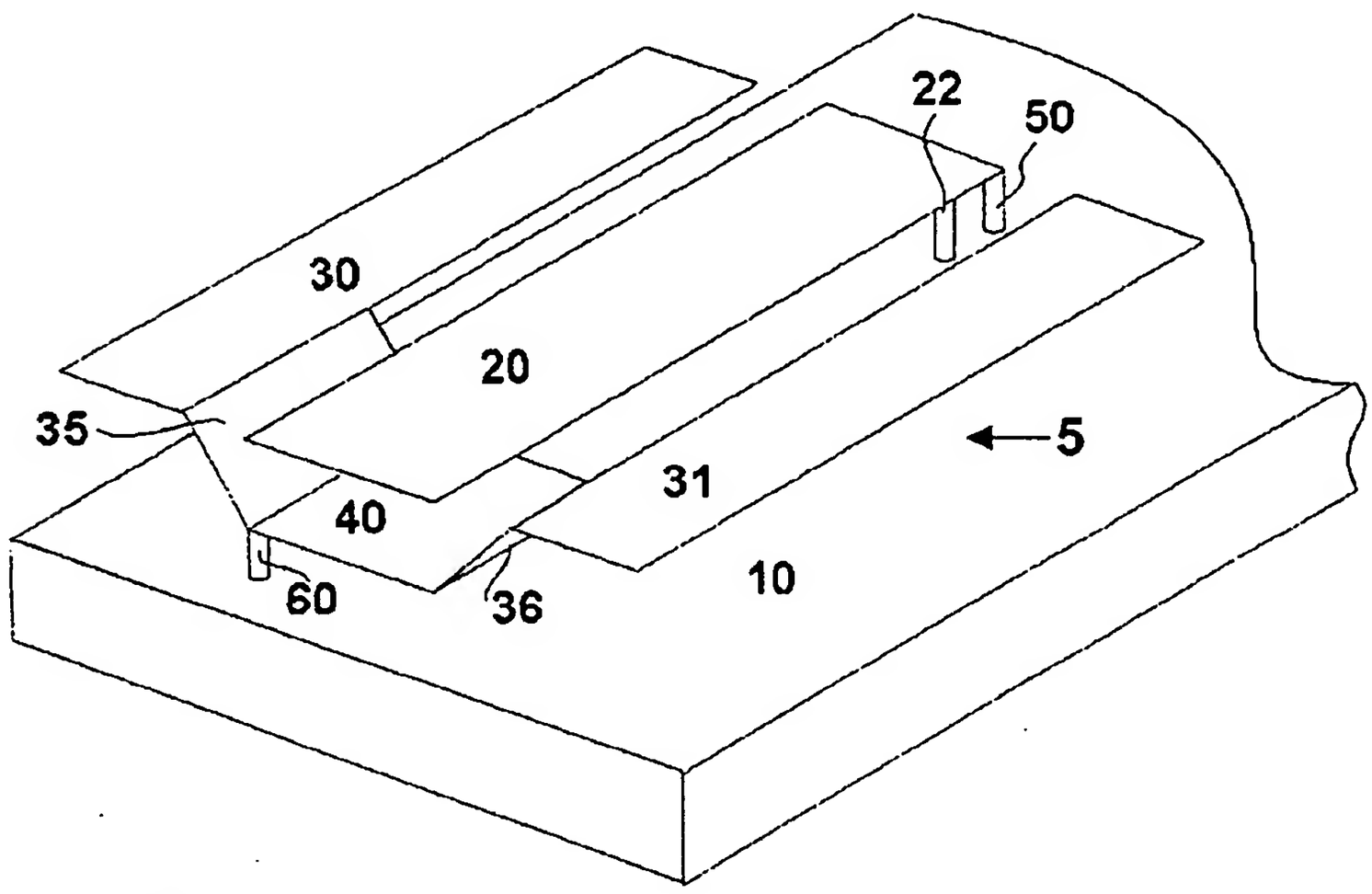

Fig 2

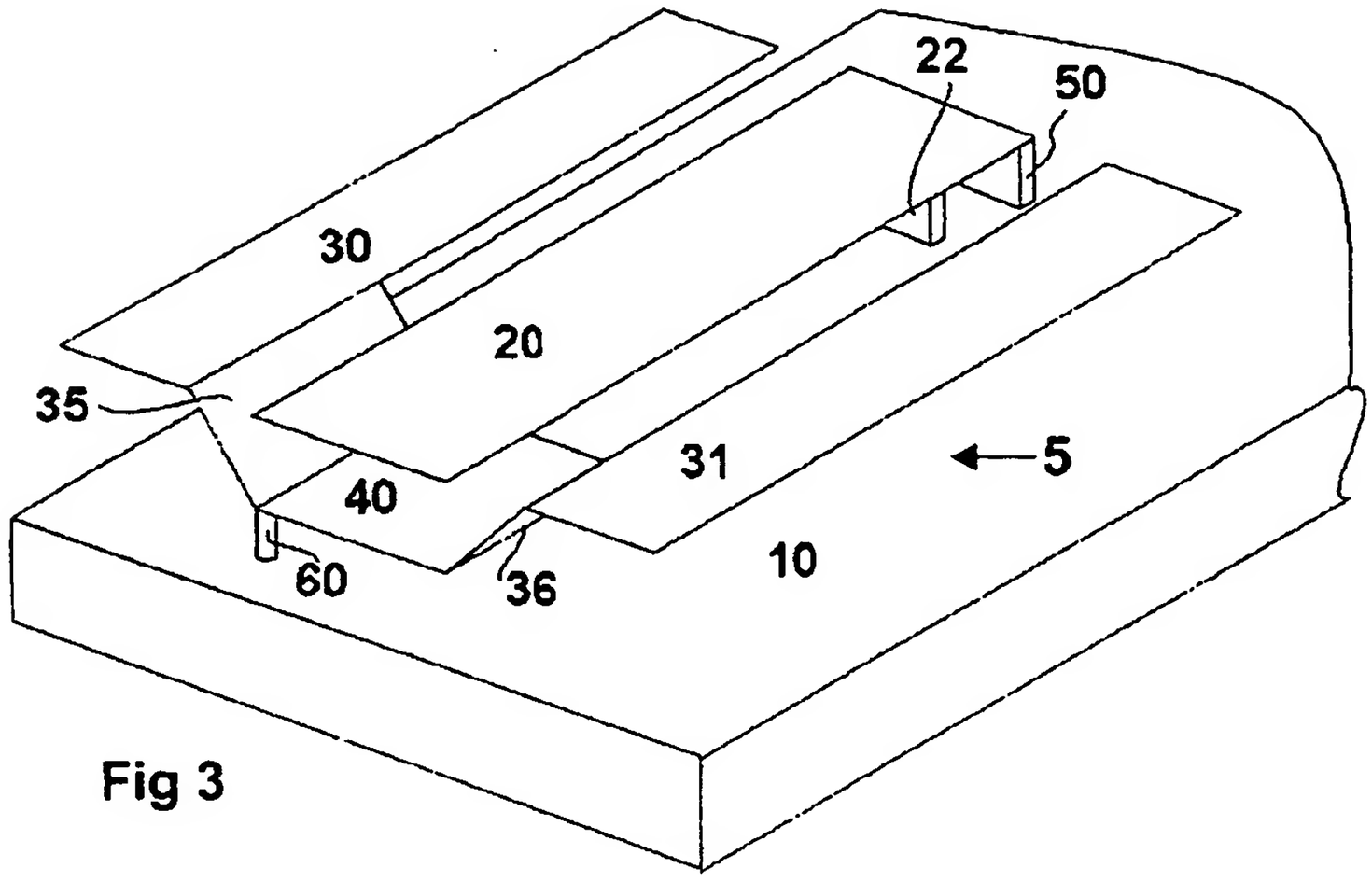

Fig 3

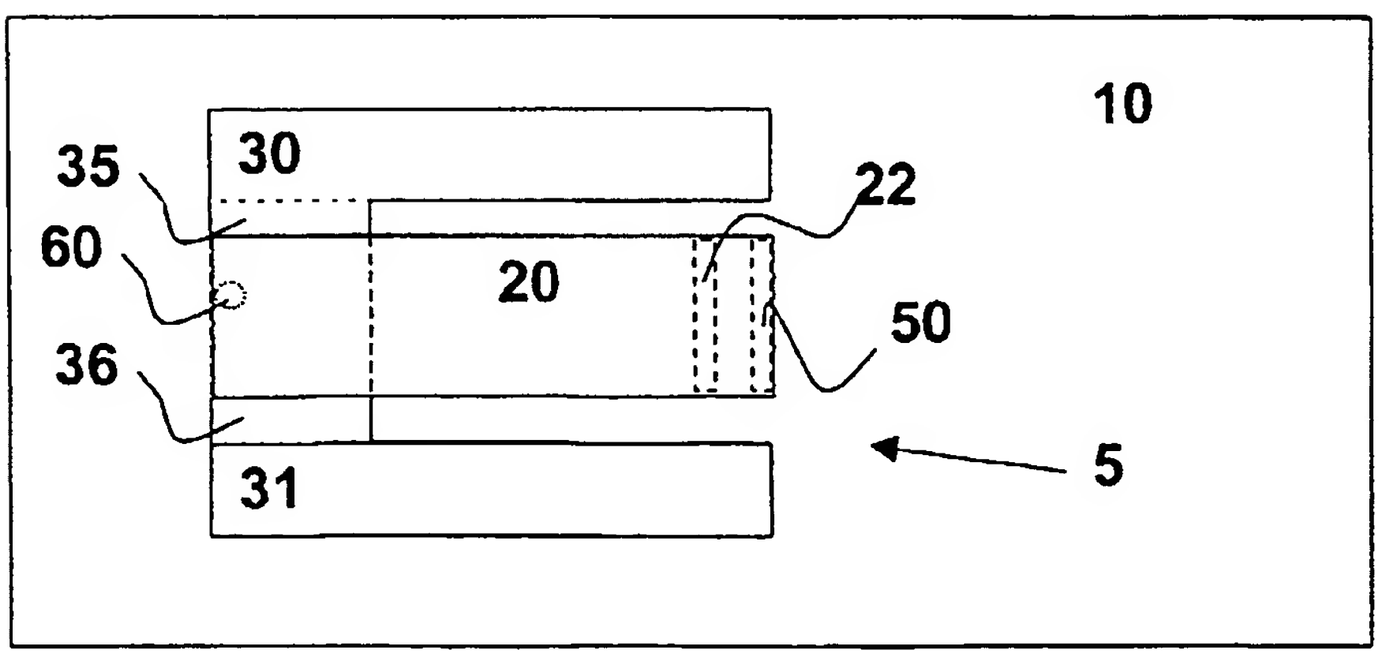

Fig 4

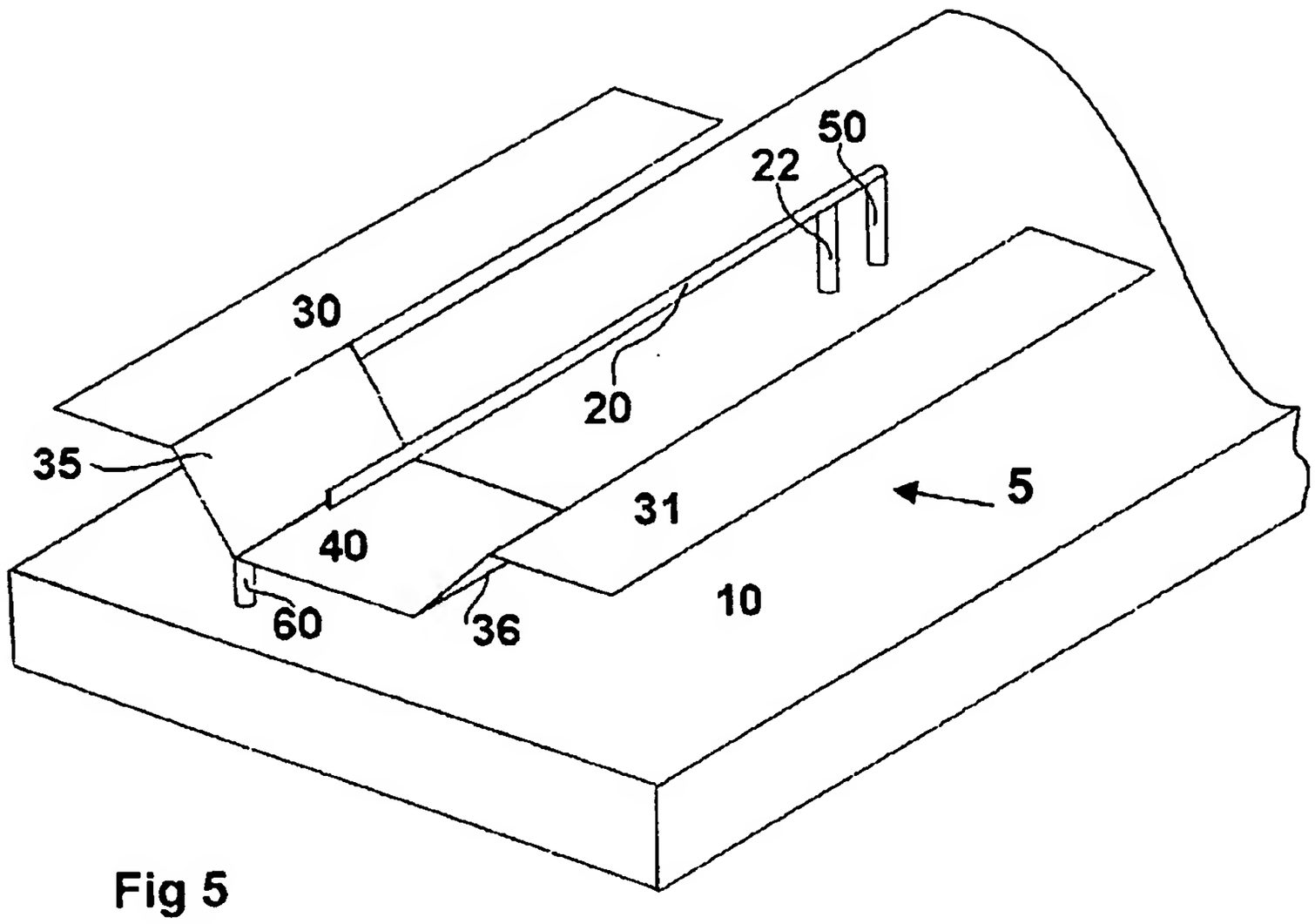

Fig 5

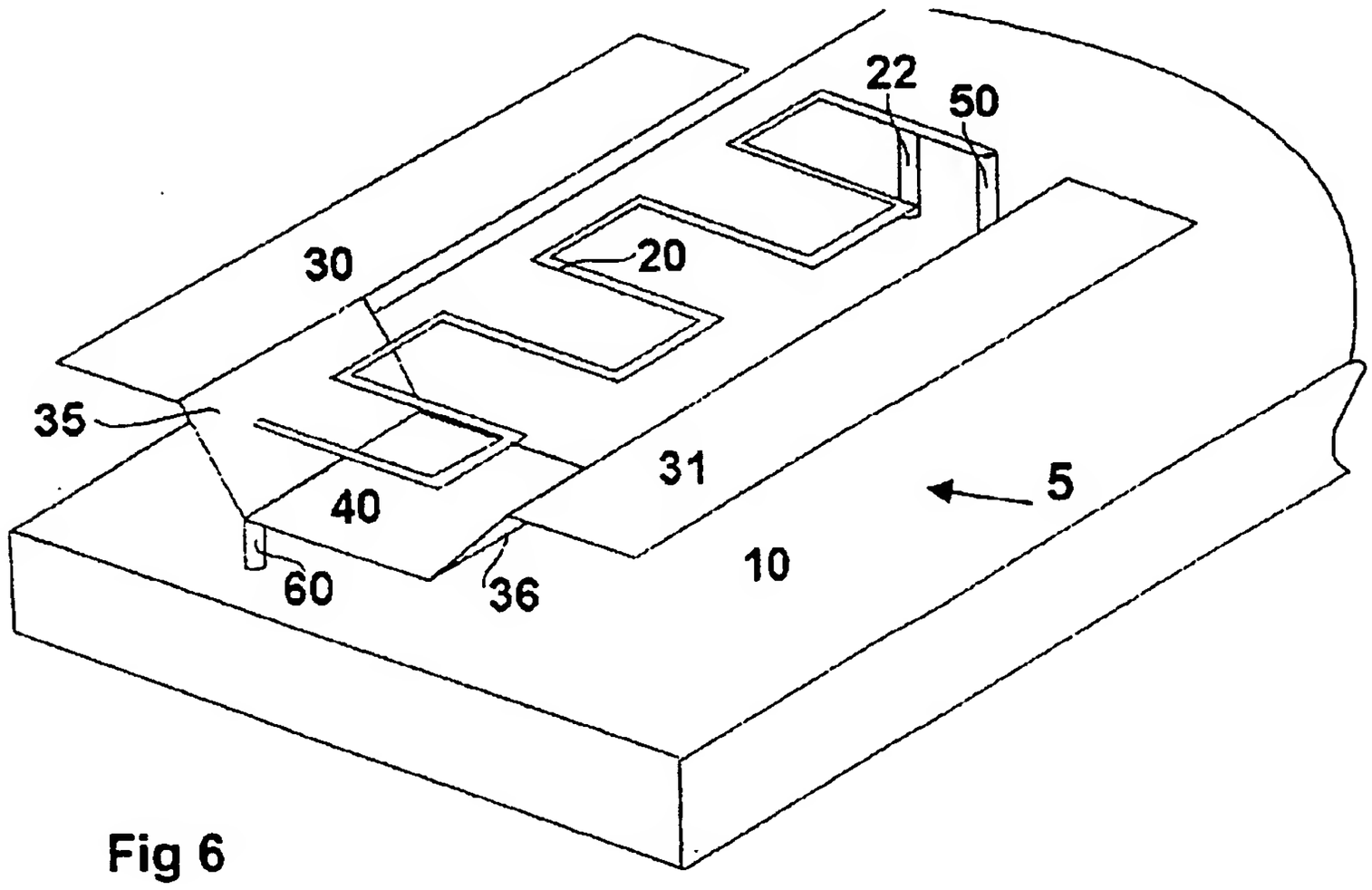

Fig 6

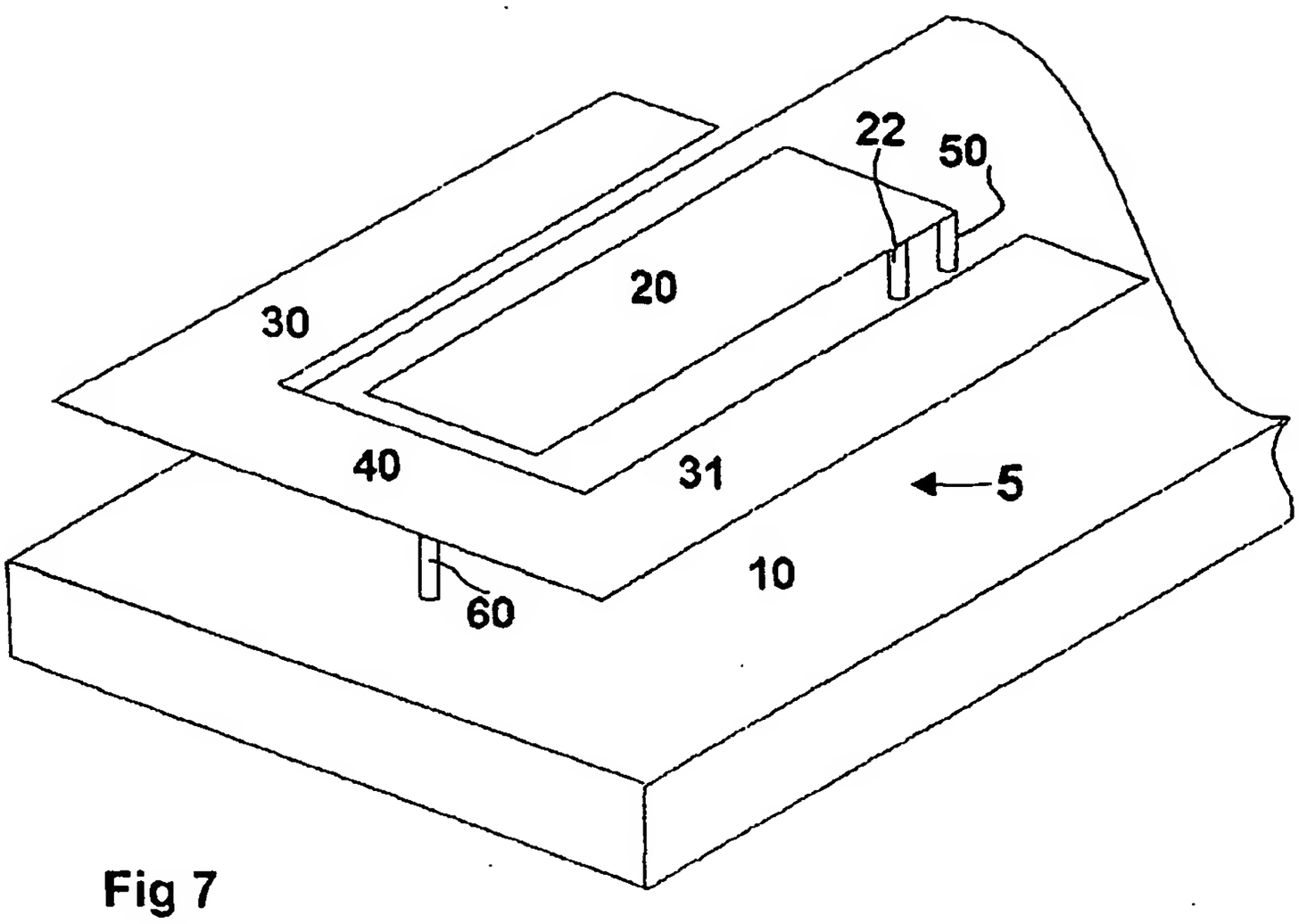

Fig 7

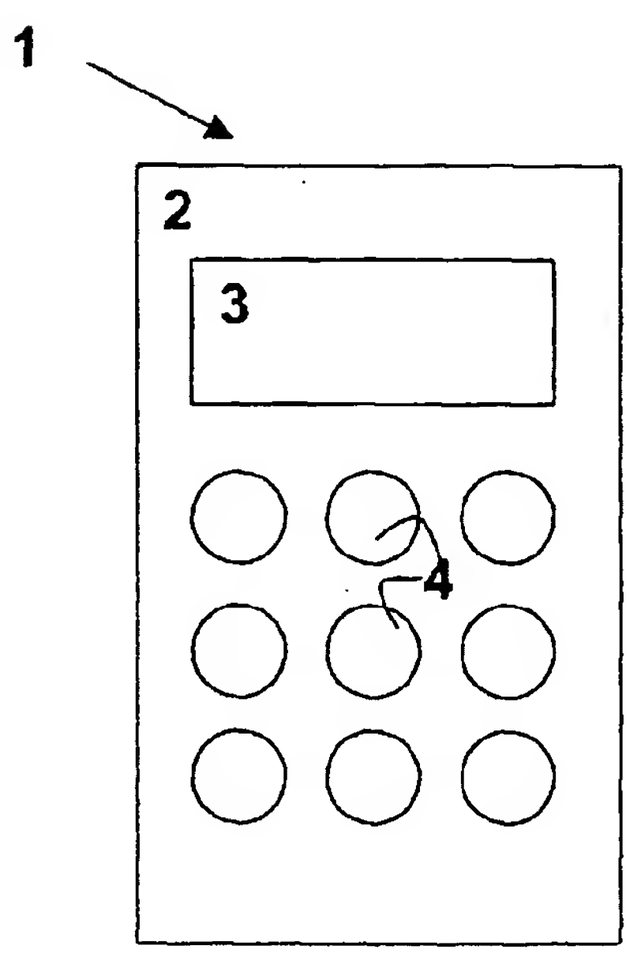

Fig 8

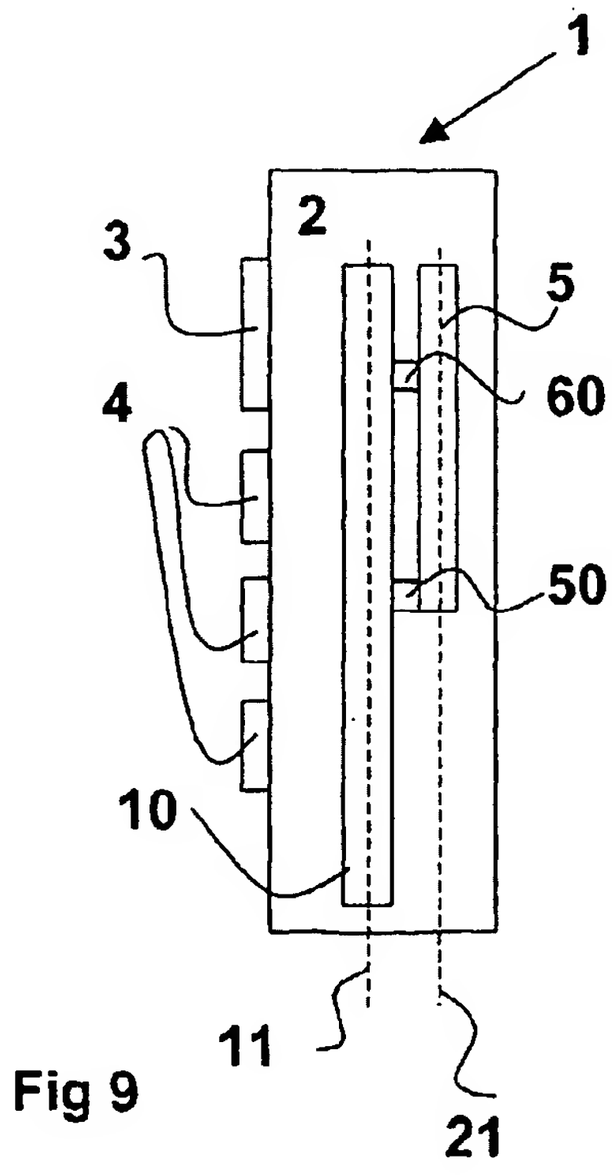

Fig 9

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EUROPEAN SEARCH REPORT

Application Number
EP 99 11 3329

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Place of search	Date of completion of the search	Examiner
THE HAGUE	25 November 1999	Van Dooren, G

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